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EVALUATION AND SELECTION OF PROJECTS USING HYBRID MCDM TECHNIQUE UNDER FUZZY ENVIRONMENT BASED ON FINANCIAL FACTORS

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ABSTRACT

Selection of project among a set of possible investment alternatives is a tough task that the decision maker (DM) has to face. For evaluation and selection of these projects, a set of six factors, i.e. Net present value, Rate of return, Benefit cost analysis, Payback period, investment size and Time until breakeven are considered. The objective of this work is to demonstrate the methodology of evaluating and selecting the best project by using hybrid multi criteria decision making technique (MCDM), i.e., fuzzy analytical hierarchy process (Fuzzy AHP) and fuzzy technique for order preference by similarity to ideal solution (Fuzzy TOPSIS). The criteria weights are calculated by using Fuzzy AHP whereas the global weights of all five projects (Investment alternatives) are computed based on Fuzzy TOPSIS. Finally, from the findings of this work, the projects are ranked from most important to least important.

KEYWORDS: Investment alternatives, Fuzzy Theory, Fuzzy AHP and Fuzzy TOPSIS

INTRODUCTION

Engineering economics is the specialized study of financial and economic aspects of the industrial decision making. The role of engineering economics is to assess the appropriateness of a given project, estimate its value, and justify it from an engineering point of view. The purpose of engineering economy deals with the methods used in evaluation of projects. The main objective is to determine the "best projects".

There is a large literature dedicated to the project selection problem. It includes several approaches, which take into account various aspects of the problem. Strategic intent of the project, factors for project selection models has been thoroughly discussed by Meredith and mantle (2000).Danila (1999), Shpak and Zaporojan (1996) surveyed a number of the project selection methodologies and discussed several multi-criteria aspects of the problem. Mehrez and Sinuany stern (1983) formulated a project selection problem as a multi-criteria decision making (MCDM) problem and applied a utility function. Chu et al. (1996) demonstrated project selection process using fuzzy theory for ranking projects.

The project selection issues have been discussed in various management functions like in research and development (loch and Kavadias (2002)), environmental management (Eugene and Dey (2005)), and quality management (Hariharan et al. (2004)). Projects are unique in nature. Hence, each model has its own pros and cons for various applications.

In our methodology first by using improved AHP with fuzzy set theory, the weight of each criterion is calculated. Then this article introduces a model that integrates improved fuzzy AHP with Fuzzy TOPSIS to support project selection decisions. The fuzzy AHP is the fuzzy extension of AHP to efficiently handle the fuzziness of the data involved in the decision making. It is easy to understand and it can effectively handle both qualitative and quantitative data in the multi-attribute decision making problems (MADM). In this approach triangular fuzzy numbers are used for the preferences of one criterion over another and then by using the extent analysis method, the synthetic extent value of the pairwise comparison is calculated.

Other sections of the article are as follows: in the section II, criteria for the project selection have been mentioned. In section III, the fuzzy set theory explains. In section IV, we present our methodology. Finally, concluding remarks are provided in section V.

The common methods of comparing alternatives the main reason is today "Worth" more than tomorrow or after one year. The cost and benefits of an investment occur over an extended period of time rather than at the moment of purchase. Consequently, financial analyses studies much accommodate the future effects of current decisions. According to a concept that economists call the time value of money, all things being equal, it is better to have money now rather than later.

The economic and financial analysis of the project is based on the comparison of the cash flow of all costs and benefits resulting from the projects activities. There are six common methods of comparing alternative investments: are Net present value, Rate of return, Benefit cost analysis, Payback period, investment size and Time until breakeven. Each of these is dependent on a selected interest rate or discount rate to adjust cash flows at different points in time (G. Lockett and M. Stratford (1987)).

The various evaluation criteria used in this paper are explained below:

A. Net Present Value

A net present value (NPV) is the present value of future cash inflows minus the cost including cost of investment calculated using an appropriate discounting method. Annual costs, future payments and gradients should be brought to the present. Converting all cash flows to present worth is often referred to as discounting. Therefore, the present value of a future cash flow represents the amount of money today, which, if invested at a particular interest rate, will grow to the amount of the future cash

flow at that time in the future. The process of finding present values is called discounting and the interest rate used to calculate present values is called the discount rate. That is a zero NPV means the project repays original investment plus the required rate of return. A positive or a negative NPV means a better or worse return, respectively, than the return from zero NPV.
The main advantages of the NPV method are as follows:

- It gives the correct decision advice assuming a perfect capital market. It also gives correct ranking for mutually exclusive projects.
- It is simple to calculate.
- Varying discount rate throughout the project can be taken into account.
- It can be used to rank alternative investments because it focuses on absolute wealth created by the project.
- The limitations of the NPV
- Fit assumes that income comes or goes in annual bursts
- It's difficult to predict future discount rates and therefore, in many times, it assumes that the discount rate will be constant in the future.
- It is often difficult to predict future cash flows with certainty
- It ignores other factors that are of importance to project choice. Yet these other non-financially quantifiable factors may include socio responsibility and strategic issues.

B. Rate of Return
The internal rate of return (ROR) method to analyze investment reflects and accounts for a major purchase or project allows you to consider the time value of money. Internal rate of return (IRR) is the discount rate which makes the net present value of revenue flows equal to zero or the investment equal to the present value of revenue flows. If more than one interest factor is involved, the solution is by trial and error. The calculated interest rate may be compared to a discount rate identified as the "Minimum attractive rate of return (MARR)" or to the interest rate yielded by alternatives. Rate-of-return (ROR) analysis is useful when the selection of a number of projects is to be undertaken within a fixed or limited capital budget.

The advantages of the ROR method are as follows:

- Knowing a return is intuitively appealing
- It is a simple way to communicate the value of a project to someone who does not know all the estimation details
- If the IRR is high enough, you may not need to estimate a required return, which is often a difficult task
- Limitations of ROR
- It does not help much in ranking projects of differing sizes or levels of investments
- Non-conventional cash flows produce multiple ROR's

C. Benefit-Cost Analysis
A benefit-cost analysis is a systematic evaluation of the economic advantages (Benefits) and disadvantages (Costs) of a set of investment alternatives. Benefit-cost (B/C) analysis is a method of comparison, in which the consequences of an investment are evaluated in monetary terms and divided into the separate categories of annual equivalents or present worth for comparison.

The important steps of a benefit-cost analysis are Ghasemzadeh (1999):

1. Identification of relevant benefits and costs
2. Measurement of these benefits and costs
3. Selection of best alternative
4. Treatment of uncertainty

D. Payback Period
Probably the simplest form of financial analysis is the payback period analysis, which simply takes the capital cost of the investment and compares that value to the net annual revenues that investment would generate. Since this method ignores the time value of money and cash flows after the payback period, it can provide only a partial picture of whether the investment is worthwhile. The payback period represent the amount of time that it takes for a capital budgeting project to recover its initial cost. The use of the payback period as a capital budgeting decision rule specifies that all independent projects with a payback period less than a specified number of years should be accepted. When choosing among mutually exclusive projects, the project with the quickest payback id preferred. Both ROR and NPV employ the notion of time value of money while PBP doesn't. this would ideally mean that the ranking according to PBP is inferior, this may not necessarily always be the case though; imagine if you are investing in a country where political transition is a huge risk. Here a project that can pay back as quickly as possible would be of priority.

The payback period suffers from several flaws. For instance:

- It ignores the time value of money,
- Does not consider all of the projects cash flows, and
- The accept/reject criterion is arbitrary.

E. Investment Size
The investment amount was briefly discussed in the valuation of money invested to startup the business. However, another aspect needs to be fully understood when raising money in a competitive environment with large VC funds. This is that the pre-money valuation goes up with the amount of money raised if all other things are held constant. This is especially important when considering large VC funds as they have a lot of money to put to work.

The investor is willing to be flexible about pre-money valuation. The amount of invested cash spent by the company makes no difference to the ownership percentages (although investors are usually very interested in their portfolio companies' cash flows). In a competitive environment, this is easy to justify. Simply put, a higher amount of money yields a higher pre-money valuation because the percentage ownership enters into the rationale on both sides.

F. Time until breakeven
Your break-even point is the point at which your business is producing enough revenue each month to cover all your fixed and variable costs. Calculating the break-even point will give you an excellent idea of the costs involved in your business and the level of sales you will need to generate to cover your costs, which in turn will affect your overall business strategy. How much business you have to generate (either number of products or units of service) in a given time to break even can be calculated using the equation below.

You will break even when: **Total revenue per month = Total costs per month**
Unit sale price × Unit sales = Total monthly fixed costs + (Unit variable cost × Unit sales)
(Unit sale price × Unit sales) – (Unit variable cost × Unit sales) = Total fixed costs
(Unit sale price – Unit variable cost) × Unit sales = Total fixed costs
Unit sales per month = Total fixed costs/Unit sale price – Unit

variable cost

Once you know how much you need to sell in one month to break even, you can work out from your sales projections how long it will take for your business to reach this point.

2. METHODOLOGY

2.1 Structure the Decision Hierarchy

In this paper, five different projects: project 1, project 2, project 3, project 4 and project 5 are considered. For evaluation and selection of these projects, six set of factors: (Net present value, Rate of return, Benefit cost analysis, Payback period, investment size and Time until breakeven)are considered. Figure 1 demonstrates the hierarchical structure of the model representing the number of levels involved in the problem. Level 1, level 2 and level 3 indicate the overall objective of the problem, the set of criteria used, and the decision alternatives respectively.

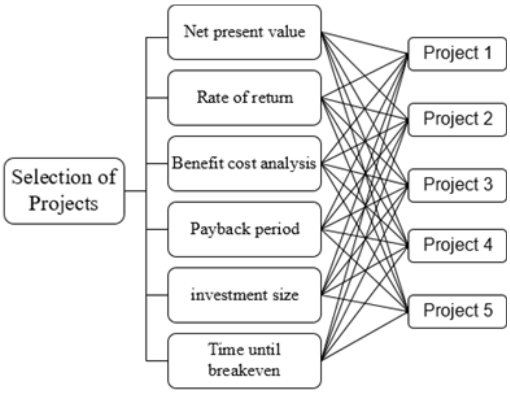

Fig 1. Overview of project selection

In general, the decision of project selection should include the reality of the multiple objectives of both the firm and its managers. Without the use of any common measurement system, it is very difficult for direct comparison of different projects. The consideration of project risks, technical risks, cost, time, and market risks are said to be more important while evaluating multiple projects. The capacity of the manufacturing firm should be sufficient enough to simulate various internal and external situations of a project and to optimize the decision of project selection. Also, the firm has to consider the major set of risks and constraints of projects.

The range of conditions that the firm experiences in future must be flexible enough. Also, should be easily modified, or to be self-adjusting in response to changes in firm environment. Ease of use is another important criterion in evaluation and selection of projects. Project evaluation should not involve special interpretation, data that is said to be very difficult to get, excessive personnel, unavailable equipment. Also, the process of project selection should be easy to simulate the desired out comes associated with project investment. Further, the cost of data collection and modelling should be low compared to the cost as well as potential benefits of the project. Also, information gathering and storage in a computer data base must be convenient and easy. Thus, the evaluation and selection of projects under multiple goals is a challenging and worthwhile in nature.

2.2 Fuzzy AHP Methodology

Step 1. Construction of fuzzy pair-wise comparison matrix:

The fuzzy judgement matrix A= $\{a_{ij}\}$ of n criteria or Alternatives using pair-wise comparison made by the use of TFNs as follows:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix}$$

Where a_{ij} is a Fuzzy Triangular Number

Step 2. Compute the value of Fuzzy Synthetic Extent

Based on the aggregated pair-wise comparison matrix, A = $\{a_{ij}\}$, the value of fuzzy synthetic extent S w.r.t the i_{th} criterion is calculated as follows

$$S_i = \sum_{j=1}^{n} a_{ij} \otimes [\sum_{i=1}^{n} \sum_{j=1}^{m} a_{ij}]^{-1}$$

Where

$$\sum_{j=1}^{m} a_{ij} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \text{ And } \sum_{i=1}^{n} \sum_{j=1}^{m} a_{ij} = \left(\sum_{i=1}^{n} l_j, \sum_{i=1}^{n} m_j, \sum_{i=1}^{n} u_j \right)$$

Step 3. Approximation of fuzzy priorities

On the basis of fuzzy synthetic extent values, the non-fuzzy values representing the relative preferences or weight of one criterion over others i.e. the degree of possibility are calculated using Chang's method as expressed below

$$V(S_i \geq S_j) = \begin{cases} 1, & \text{if } m_i \geq m_j \\ \dfrac{(u_i - l_j)}{(u_i - m_i) + (m_j - l_j)}, & \text{if } l_j \leq u_i \\ 0, & \text{others} \end{cases},$$

Where $i, j = 1, \dots\dots, n; j \neq i$

The degree of possibility for a TFN S_i to be greater than the number of **n** TFNs can be given by $V(S_i \geq S_1, S_2, S_3, \dots S_k) = \min (S_i \geq S_1, S_i \geq S_2, \dots, S_i \geq S_k) = w(S_i)$ where $k \neq i$ .Each w(S_i) value represents the relative preferences or weight, a non-fuzzy number, of one criterion over others.

Step 4. Determination of Normalized Weights

The normalized weights W(S_i) will be formed in terms of a weights vector as follows:

$$W = (w(S_1), w(S_2), \dots . w(S_n))^T$$

2.3 Fuzzy TOPSIS Methodology

In the following section, some basic important definitions of fuzzy sets from Zimmermann (1991), Buckley (1985), Zadeh (1965), Kaufmann and Gupta (1991), Yang and Hung (2007) and Chen et al. (2006) are reviewed and summarized. It is often difficult for a DM to assign a precise performance rating to an alternative for the criteria under consideration. The merit of using a fuzzy approach is to assign the relative importance of criteria using fuzzy numbers instead of precise numbers. This subsection extends TOPSIS to the fuzzy environment.

Definition 1: Let $\tilde{a} = (l_1, m_1, u_1)$ and $\tilde{b} = (l_2, m_2, u_2)$ be two TFNs, then the vertex method is defined to calculate the distance between them, as equation:

$$d(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{3}\left[(l_1 - l_2)^2 + (m_1 - m_2)^2 + (u_1 - u_2)^2 \right]}$$

The problem can be described by following sets:

i. A set of J possible candidates called A= {A_1, A_2,…A_j}
ii. A set of n criteria, C={ C_1, C_2,…C_j }
iii. A set of performance ratings of A_j(j=1,2,3….., J) with respect to criteria C_i(i = 1,2,3 .., n) called $\tilde{X} = \{\tilde{x}_{ij}\ i = 1, 2, 3, \dots, n,\ j = 1, 2, 3, \dots, J\}$
i. A set of importance weights of each criterion $w_i\ (i = 1, 2, 3, \dots n)$

As stated above, problem matrix format can be expressed as follows:

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & . & . & . & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & . & . & . & \tilde{x}_{2n} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ \tilde{x}_{J1} & \tilde{x}_{J2} & . & . & . & \tilde{x}_{Jn} \end{bmatrix}$$

Definition 2: Considering the different importance values of each criterion, the weighted normalized fuzzy-decision matrix is constructed as:

$$\tilde{V} = [\tilde{v}_{ij}]_{n \times J} \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J$$

According to the briefly summarized fuzzy theory above, fuzzy TOPSIS steps can be outlined as follows:

Step 1: Choose the linguistic ratings $(\tilde{x}_{ij}\ i = 1,2,3\ldots,n,\ j = 1,2,3\ldots..J)$ for alternatives with respect to criteria. The fuzzy linguistic rating $(\tilde{x}_{ij})$ preserves the property that the ranges of normalized TFNs belong to [0, 1]; thus, there is no need for normalization. Let $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}), \tilde{x}_j^- = (a_j^-, b_j^-, c_j^-)$ and $\tilde{x}_j^* = (a_j^*, b_j^*, c_j^*)$. we have

$$\tilde{r}_{ij} = \begin{cases} \tilde{x}_{ij}(\div)\tilde{x}_j^* = \left(\dfrac{a_{ij}}{a_j^*}, \dfrac{b_{ij}}{b_j^*}, \dfrac{c_{ij}}{c_j^*}\right) \\ \tilde{x}_j^-(\div)\tilde{x}_{ij} = \left(\dfrac{a_j^-}{a_{ij}}, \dfrac{b_j^-}{b_{ij}}, \dfrac{c_j^-}{c_{ij}}\right) \end{cases}$$

Step 2: Calculate the weighted normalized fuzzy decision matrix. The weighted normalized value $\tilde{v}_{ij}$ calculated by eq.

Step 3: Identify positive ideal (A*) and negative ideal (A-) solutions. The fuzzy positive ideal solution (FPIS, A*) and the fuzzy negative ideal solution (FNIS, A-) are shown in equation

$$A^* = \{\tilde{v}_1^*, \ldots, \tilde{v}_i^*\}$$
$$= \left\{\left(\max_j v_{ij} \mid i \in I'\right), \left(\min_j v_{ij} \mid i \in I''\right)\right\}$$

$i = 1,2,\ldots n,\ j = 1,2,\ldots.J$ Where I' is associated with benefit criteria and I'' is associated with cost criteria.

Step 4: Calculate the distance of each alternative from A* and A- using equation

$$D_j^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_i^*) \quad j = 1,2,\ldots..J$$

$$D_j^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_i^-) \quad j = 1,2,\ldots..J$$

Step 5: Calculate similarities to ideal solution.

$$CC_j = \frac{D_j^-}{D_j^* + D_j^-} \quad j = 1,2,\ldots..J$$

Step 6: Rank preference order. Choose an alternative with maximum CC_j^* or rank alternatives according to CC_j^* in descending order.

3. NUMERICAL ILLUSTRATION

Our application is to relate to manufacturing sector the main aim is to select the best project among the available five alternatives. There are three decision makers in the committee. Then evaluation criteria are determined as Net present value (C1), Rate of return (C2),, Benefit cost analysis (C3),, Payback period (C4),, investment size (C5) and Time until breakeven (C6).

3.1 Application with FUZZY AHP

In this section fuzzy AHP method is proposed for the determination of the weights of the evaluation criteria. Firstly three decision makers evaluated and prepared the pair wise comparison matrix using the linguistic variables. Finally the weights of the criteria are determined in the following manner explained below.

Linguistic Terms	Triangular Fuzzy Numbers	Reciprocals
Equally Important	(1,1,1)	(1,1,1)
Extremely Low Important	(1,1,2)	(1/2,1,1)
Very Low Important	(1,2,3)	(1/3,1/2,1)
Low Important	(2,3,4)	(1/4,1/3,1/2)
Moderately Low Important	(3,4,5)	(1/5,1/4,1/3)
Important	(4,5,6)	(1/6,1/5,1/4)
Moderately High Important	(5,6,7)	(1/7,1/6,1/5)
High Important	(6,7,8)	(1/8,1/7,1/6)
Very High Important	(7,8,9)	(1/9,1/8,1/7)
Extremely High Important	(8,9,9)	(1/9,1/9,1/8)

Table 1. Fuzzy Comparison Measures

Criteria No	C1	C2	C3	C4	C5	C6
C1	(1,1,1)	(1/8,1/7,1/6)	(1/7,1/6,1/5)	(1,1,2)	(2,3,4)	(1,2,3)
C2	(6,7,8)	(1,1,1)	(1/5,1/4,1/3)	(2,3,4)	(1/8,1/7,1/6)	(1/3,1/2,1)
C3	(5,6,7)	(3,4,5)	(1,1,1)	(1/6,1/5,1/4)	(1,2,3)	(1/5,1/4,1/3)
C4	(1/2,1,1)	(1/4,1/3,1/2)	(4,5,6)	(1,1,1)	(5,6,7)	(1,1,2)
C5	(1/4,1/3,1/2)	(6,7,8)	(1/3,1/2,1)	(1/7,1/6,1/5)	(1,1,1)	(1,2,3)
C6	(1/3,1/2,1)	(1,2,3)	(3,4,5)	(1/2,1,1)	(1/3,1/2,1)	(1,1,1)

Table 2. Inter-Criteria Comparison Matrix

The value of fuzzy synthetic extent with respect to the ith object (i= 1, 2, 3, 4, 5, 6) is calculated as

Sc_1 = (5.2679 7.3095 10.3667) ⊗ (51.9357 66.9857 84.6500) = (0.0622 0.1091 0.1996)

Sc_2 = (9.6583 11.8929 14.5000) ⊗ (51.9357 66.9857 84.6500) = (0.1141 0.1775 0.2792)

Sc_3 = (10.3667 13.4500 16.5833) ⊗ (51.9357 66.9857 84.6500) = (0.1225 0.2008 0.3193)

Sc_4 = (11.7500 14.3333 17.5000) ⊗ (51.9357 66.9857 84.6500) = (0.1388 0.2140 0.3370)

Sc_5 = (8.7262 11.0000 13.7000) ⊗ (51.9357 66.9857 84.6500) = (0.1031 0.1642 0.2638)

Sc_6 = (6.1667 9.0000 12.0000) ⊗ (51.9357 66.9857 84.6500) = (0.0728 0.1344 0.2311)

Then the 'V' is calculated using these fuzzy values using the equation

Where $i, j = 1,\ldots\ldots.., n; j \neq i$

$V(Sc_1 \geq Sc_2) = 0.5555$, $V(Sc_1 \geq Sc_3) = 0.4570$
$V(Sc_1 \geq Sc_4) = 0.3670$, $V(Sc_1 \geq Sc_5) = 0.6366$
$V(Sc_1 \geq Sc_4) = 0.8340$

$V(Sc2 \geq Sc1) = 1.0000$, $V(Sc2 \geq Sc3) = 0.8708$
$V(Sc2 \geq Sc4) = 0.7940$, $V(Sc2 \geq Sc5) = 1.0000$
$V(Sc2 \geq Sc6) = 1.0000$

$V(Sc3 \geq Sc1) = 1.0000$, $V(Sc3 \geq Sc2) = 1.0000$
$V(Sc3 \geq Sc4) = 0.9319$, $V(Sc3 \geq Sc5) = 1.0000$
$V(Sc3 \geq Sc6) = 1.0000$

$V(Sc4 \geq Sc1) = 1.0000$, $V(Sc4 \geq Sc2) = 1.0000$
$V(Sc4 \geq Sc3) = 1.0000$, $V(Sc4 \geq Sc5) = 1.0000$
$V(Sc4 \geq Sc6) = 1.0000$

$V(Sc5 \geq Sc1) = 1.0000$, $V(Sc5 \geq Sc2) = 0.9182$
$V(Sc5 \geq Sc3) = 0.7944$, $V(Sc5 \geq Sc4) = 0.7152$
$V(Sc5 \geq Sc6) = 1.0000$

$V(Sc6 \geq Sc1) = 1.0000$, $V(Sc6 \geq Sc2) = 0.7303$
$V(Sc6 \geq Sc3) = 0.6204$, $V(Sc6 \geq Sc4) = 0.5367$
$V(Sc6 \geq Sc5) = 0.8108$

Then the priority weights are calculated by using degree of possibility for a convex fuzzy number to be grater then K convex fuzzy numbers

$d'(C_1) = \min = (0.3670)$

$d'(C_2) = \min = (0.7940)$

$d'(C_3) = \min = (0.9319)$

$d'(C_4) = \min = (1.0000)$

$d'(C_5) = \min = (0.7152)$

$d'(C_6) = \min = (0.5367)$

So, the Priority Weights W' are obtained from minimum values of d' of criteria. After the normalization of these values, the Priority Weight represent to main goal is calculated as (0.0845, 0.1827, 0.2145, 0.2302, 0.1646, and 0.1235).

These weights have been used for further evaluation of ranking the projects using FUZZY TOPSIS

3.2 Application of Fuzzy TOPSIS

This this section Fuzzy TOPSIS method is proposed to select the best alternative. Firstly, three decision makers evaluated the importance of criteria by using the linguistic variables. Three decision makers use these linguistic variables to evaluate the ratings of the alternatives with respect to each criterion. The fuzzy decision matrix is as shown in Table 3.

Criteria	C1	C2	C3	C4	C5	C6
	0.0845	**0.1827**	**0.2145**	**0.2302**	**0.1646**	**0.1235**
P1	(5.67, 6.67, 7.67)	(4, 5, 6)	(2,3,4)	(5, 6, 7)	(3, 4, 5)	(3.67,4.67, 5.67)
P2	(5, 6, 7)	(5, 6, 7)	(3, 4, 5)	(7, 8, 8.67)	(4.33, 5.33, 6.33)	(4.33,5.33,6.33)
P3	(4.33,5.33,6.33)	(3, 4, 5)	(3.67,4.67,5.67)	(5.33,6.33,7.33,)	(5.33,6.33,7.33)	(4.67,5.67,6.67)
P4	(5.33,6.33,7.33)	(4.67,5.67,6.67)	(4,5,6)	(6,7,8)	(4.33,5.33,6.33)	(4,5,6)
P5	(6,7,8)	(3.67,4.67,5.67)	(2.33,3.33,4.33)	(6.67,7.67,8.67)	(5,6,7)	(3,4,5)

Table 3. Fuzzy Decision Matrix and fuzzy weights

Criteria	C1	C2	C3	C4	C5	C6
P1	(0.4791, 0.5636, 0.6481)	(0.7308, 0.9135 , 1.0962)	(0.4290,0.6435,0.8580)	(1.1510,1.3812,1.6114)	(0.4938,0.6584,0.8230)	(0.4532, 0.5767, 0.7002)
P2	(0.4225, 0.5070 , 0.5915)	(0.9135, 1.0962 , 1.2789)	(0.6435,0.8580,1.0725)	(1.6114,1.8416,1.9958)	(0.7127,0.8773,1.1419)	(0.5348,0.6583,0.7818)
P3	(0.3659,0.4504,0.5349)	(0.5481,0.7308,0.9135)	(0.7872,1.0017,1.2162)	(1.2270,1.4572,1.6874)	(0.8773,1.0419,1.2065)	(0.5767,0.7002,0.8237)
P4	(0.4504,0.5349,0.6194)	(0.8532,1.0359,1.2186)	(0.8580,1.0725,1.2870)	(1.3812,1.6114,1.8416)	(0.7127,0.8773,1.0419)	(0.4940,0.6175,0.7410)
P5	(0.5070,0.5915,0.6760)	(0.6705,0.8532,1.0359)	(0.4998,0.7143,0.9288)	(1.5354,1.7656,1.9958)	(0.8230,0.9876,1.1522)	(0.3705,0.4940,0.6175)

Table 4. Weighted normalized fuzzy decision matrix

	C1	C2	C3	C4	C5	C6	D^*
P1	0.9374	0.8987	0.9287	0.8468	0.9270	0.0651	4.6036
P2	0.9437	0.8784	0.9049	0.7984	0.9026	0.0740	4.5020
P3	0.9500	0.9189	0.8889	0.8384	0.8844	0.0786	4.5592
P4	0.9406	0.8851	0.8810	0.8212	0.9026	0.0695	4.5001
P5	0.9343	0.9054	0.9208	0.8041	0.8904	0.0560	4.5110

Table 5. Distance of each alternative from FPIS (fuzzy positive ideal solution)

	C1	C2	C3	C4	C5	C6	D-	CC_j	Ranking
P1	0.0631	0.1028	0.0741	0.1549	0.0747	0.9360	1.4056	0.2339	5
P2	0.0569	0.1229	0.0973	0.2026	0.0986	0.9269	1.5052	0.2506	2
P3	0.0506	0.0829	0.1130	0.1632	0.1167	0.9223	1.4487	0.2411	4
P4	0.0599	0.1163	0.1207	0.1803	0.0986	0.9315	1.5073	0.2509	1
P5	0.0662	0.0962	0.0817	0.1973	0.1107	0.9452	1.4973	0.2492	3

Table 6. Distance of each alternative from FNIS (fuzzy negative ideal solution) and Relative closeness values

The weighted normalized fuzzy decision matrix is formed as shown in Table 4. We define fuzzy positive ideal solution (FPIS, A*) and a fuzzy negative ideal solution (FNIS, A^-) as $\tilde{v}_i^* = (1,1,1)$ *and* $\tilde{v}_i^- = (0,0,0)$ for benefit criterion and $\tilde{v}_i^* = (0,0,0)$ *and* $\tilde{v}_i^- = (1,1,1)$ for cost criteria. The distances of each alternative from FPIS and FNIS with respective each criterion are shown in Table 5 and Table 6. D^* and D^- are shown in Table 5 and Table 6 then closeness coefficient of five alternatives are calculated and tabulated in Table 6. According to the closeness coefficient of five alternatives, the ranking order of five alternatives is determined as P4>P2>P5>P3>P5. The fourth alternative is determined as a most appropriate alternative. In other words the fourth alternative is closer to the FPIS and farther from the FNIS.

4. CONCLUSION

It's found that the application results satisfactory and decided to select the best alternative Projects. Under environment using Fuzzy AHP and Fuzzy TOPSIS methods are appropriate for evaluation and selection of projects. But there is a limitations and advantages in these methods according to the problem that chosen. Here the project 4 is first priory and project 1 is least priory according to the criteria chosen for evaluation and selection of projects under fuzzy environment.

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